To add to the understatement of cost, the Hatfield Model Version 3.0/3.1 makes no provision for manholes or pullboxes in the distribution system despite their widespread use in the real world, even though the Hatfield Model Version 3.0/3.1 places conduit there. Even the Hatfield Model Version 3.0/3.1 documentation acknowledges that "underground cable is always housed in conduit facilities that extend between manholes or pullboxes." It is typical to place small manholes (pullboxes or handholes) when placing conduit in the distribution to provide an enclosure for splicing, cable pulling, or terminating drop wire. While it is possible to terminate conduit in pedestals, there is no indication that the costs for such pedestals were included. If manholes and pullboxes are included in the distribution network in later Hatfield Model versions, the manhole or pullbox spacings in the distribution system should default to a shorter distance than manhole spacings in the feeder network because the distribution manholes serve smaller areas.

Assuming the purchase of fiber cable in 2-kilometer lengths, and assuming the pullbox spacing default value of 2 kilometers shown in the Hatfield Model Version 3.0/3.1, it appears that the model makes no provision for splicing and racking. Pullbox spacings of 1.95 kilometers (center to center) would yield better results for this reason.

The introduction of feeder route pullboxes for fiber cables in Version 3.0/3.1 of the Hatfield Model is an improvement. However, the apparently exclusive use of manholes by copper cables precludes the use of manholes by both types of cables. This will skew the total costs calculated by the Hatfield Model Version 3.0/3.1: the specification of more fiber cable will reduce the hypothetical number of manholes and therefore reduce, at least on paper, the cost of elements. The true cost will rise when a higher proportion of manholes is placed in the real world.

Plausibility

The Hatfield Model Version 3.0/3.1 apparently incorporates no provision for growth, presumably because of the "green fields" (or "scorched node") approach dictated by the forward-looking cost assumption. However, sound engineering principles and least total cost economic planning principles dictate the assumption of some growth and the design of a distribution system that will accommodate ultimate demand. This is particularly compelling in view of the expected growth in demand for services that the Joint Board currently defines as "unsupported".

The Hatfield Model Version 3.0/3.1 assumes that ELECs or ILECs will build this network instantaneously. This, of course, is an unreasonable assumption. This is more than a philosophical problem. The assumption precludes satisfying the Hatfield Model Version 3.0/3.1's expectations related to joint construction and structure sharing, certainly for buried placement and probably for many underground placements.

The Hatfield Model Version 3.0/3.1 assumes that the ELEC or the ILEC will build the local network to satisfy a perfectly known demand. Consequently, the Hatfield Model Version 3.0/3.1 does not appear to include any break down of costs to reflect variable construction quantities. This makes any attempt to compare the specified unit prices with professional experience very difficult.

Poles

The aerial structure investments are understated in Hatfield Model Version 3.0/3.1. The Hatfield Model Version 3.0/3.1 does not include costs for support strand, attachment hardware, guys and anchors in the costs specified for aerial facilities. In addition, pole costs are too low in both versions. However, the Hatfield Model Version 3.0/3.1 developers have somehow determined that a larger size pole costs less

than a smaller pole. Version 2.2, Release 2 of the Hatfield Model assumed the placement of a 35-foot pole for $450, while Version 3.0/3.1 assumes the placement of a 40-foot pole for only $417. In any event, ILEC or ELEC would need to place a 45-foot, class 4 pole, at even greater cost, to accommodate primary and secondary power attachments.

Splicing

Splicing costs appear to have been removed from the Hatfield Model Version 3.0/3.1. Consequently, we have been unable to subject splicing costs or assumptions to direct evaluation.

Switch

The Hatfield Model Version 3.0/3.1 does not appear to support proper host/remote switching designs. Although the Hatfield Model Version 3.0/3.1 suggests the use of remote terminals, the only cost data provided appear to be derived from central office "per-line" costs. We recommend an evaluation of the data and clarification of this issue.

The 25,000 line and 50,000 line switch sites are major site builds. The costs used do not reflect the substantially higher construction costs associated with such a build. The Hatfield Model Version 3.0/3.1 appears to reflect the costs associated with small room or small site switches and to exclude costs for power and similar ancillary equipment.

Terminals and Drops

The drop parameters have improved with Hatfield Model Version 3.0/3.1, however there are still some problems. In Version 2.2, Release 2, the drop cost per line was

a single cost for all density zones and all types of plant: $40.00 per drop. In the Hatfield Model Version 3.0/3.1, drop costs are based on an assumed mix of aerial and buried plant, a material cost per foot for both aerial and buried drops, an average length of drop and a labor cost per placement (not per foot) for aerial plant and a labor cost per foot for buried plant.

Two problems occur with this approach. First, the default material cost per foot for both types of drop is understated. Second, the assumed mix of drop types does not match the distribution cable structure mix. In the population density zone of 0 to 5 households per square mile, for example, 50 percent of the drops are assumed to be aerial yet only 25% of the structures are aerial.

Terminal and Network Interface Device ("NID") Investments are understated in Hatfield Model Version 3.0/3.1, as they were in Version 2.2, Release 2. The terminal costs per line in both versions of the Hatfield Model are not reasonable because only one cost is applied to all zones. In reality less dense zones would have a much higher cost per line because fewer households would share terminal costs.

The Hatfield Model Version 2.2, Release 2 documentation declares a 2-line NID for residential and a 4-line NID placed for businesses.[22] However, the Hatfield Model Version 3.0/3.1 places a 6-line NID for residential customers, which is not standard in a typical 2 line per household network. It appears that the Hatfield Model Version 3.0/3.1 identifies a base installed cost for the 6 pair NID at $25.00. Then the Hatfield Model Version 3.0/3.1 adds $4.00 for protection for every line it assumes is working in the NID. This yields a cost of $29.00 for a single line and a decreasing cost per line for each additional line. Installing a six line NID is not a standard practice for most telecommunications companies and it certainly is not an efficient use of plant.

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[22] Hatfield Model Release 3, February 7, 1997, model documentation, page 29 ff.

This methodology underestimates true NID costs per customer.

Terrain

The Hatfield Model Version 3.0/3.1 makes no provision for the impact of groundwater on the cost of cable placement. The documentation provided with the Hatfield Model Version 3.0/3.1 claims specifically that the effects of the water table are included, but no variable is displayed in the user interface. Moreover, the only variable that conceivably could correspond to the "water" in the database is a variable termed "difficult terrain."[23] Finally, there is no mechanism within the master database for preserving this information for subsequent analysis or repeated application.

While the Hatfield Model Version 2.2, Release 2 recognizes the impact of hard rock, it only adjusts the input value if the bedrock is within one foot of the surface. Moreover, the Hatfield Model Version 2.2, Release 2 assigns no cost multiplier for any amount of soft rock, at any depth. These assumptions drastically understate the real cost of placing facilities.

The terrain multiplier in Hatfield Model Version 3.0/3.1 has the same flaw as in Version 2.2, Release 2, but has been compounded by a seemingly contradictory additional multiplier. Version 2.2, Release 2 increases distance by 20% to go around difficult terrain. The Hatfield Model Version 2.2, Release 2 claims it is easier to go around difficult terrain than to go through it. The Hatfield Model Version 2.2, Release 2 simply adds 20 percent more cable if terrain is difficult, an unreasonable approach to the problem. Utilities must follow right of ways or utilities easements that typically follow property lines, highways, or similar features and do not meander haphazardly wherever the ground looks soft and inexpensive.

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[23] Hatfield Model Release 3.0, Appendix A – Data Inputs Development Description, page A-11 and elsewhere.

Hatfield Model Version 3.0/3.1 still applies a 20% increase in distance to go around difficult terrain (which is ridiculous to assume) as does Version 2.2, Release 2. This seems to be a contradiction. If difficult terrain is by-passed, then why have a multiplier to increase cost for difficult trenching?

Model Software and User Interface

Austin Communications Education Services successfully ran the Hatfield Model 3.0/3.1 after initial installation and testing difficulties. Both versions of the model exhibited significant software and hardware dependency problems. Although, we were able to test the models thoroughly, these problems were sufficiently noticeable to prompt our inclusion of comment in this section.

The Hatfield Model Version 3.0 release we evaluated in preparing this report was dated February 7, 1997. It contained partial data for six states: California, Colorado, New Jersey, Ohio, Texas, and Washington. The Ohio data was inaccessible to the Hatfield Model Version 3.0/3.1. Furthermore, one line of data for California was reported by the developers to be in error, which precluded evaluation of the data set for that state. The Hatfield Model Version 3.1 release we evaluated was dated February 28, 1997. As noted in the appendix, it contained a much larger data set.

The Hatfield Model Version 3.0/3.1 appeared to operate only on a Windows platform running the Microsoft Office 95 Professional software suite or on a Windows platform running Microsoft Excel 7.0 and Microsoft Access 7.0. The Austin Communications Education Services testing staff operate in a Microsoft Office 97 Professional environment and initially were unable to operate the Hatfield Model Version 3.0/3.1: the Hatfield Model Version 3.0/3.1 will not function with the most current versions of these Microsoft tools.

Given the efforts that Microsoft Corporation commits to ensure backward compatibility, we found this failure puzzling. Nevertheless, discussions with other interested parties confirmed that the Hatfield Model Version 3.0/3.1 did not function properly in current software environments but did function in an older, and in some senses obsolete environment. (We suspect, but have not confirmed, that the problem may rest

in the use of idiosyncratic Visual Basic ("VB") or Visual Basic for Applications ("VBA") macros.) After we downgraded the software, we were able to load and operate the Hatfield Model Version 3.0/3.1.

For testing purposes we used a "normal" personal computer: a 100 megahertz Pentium microprocessor equipped with 16 megabytes of memory and adequate storage (according to the software designers) running downgraded (Office 95) Microsoft software. Our first test run of the Hatfield Model Version 3.0/3.1 was for United Telephone of New Jersey. The model ran cleanly and the interpretable results were available in approximately 20 minutes. This was also the case for our third test - Warwick Telephone of New Jersey.

Our second run of the Hatfield Model Version 3.0/3.1 was for Bell Atlantic of New Jersey. The model ran for five hours before locking up and reporting a Macro Error: Run-Time error '1004'. Numerous other run-time, memory and storage errors were encountered throughout testing, including OLE automation errors (for example, Error Number –2147023170). Subsequently, we were able to complete execution by increasing the storage available.

For database analysis we used a 200-megahertz Pentium processor with 32 megabytes of memory. This facilitated the analysis of the 24-megabyte Access database used as a master repository by the Hatfield Model Version 3.0/3.1. Due to conflicting systems demands, downgrading the Microsoft software on this machine was not an option during the testing period.

Anecdotal evidence from third party evaluators suggests that multiple runs of the Hatfield Model Version 3.0/3.1 do not generate consistent results in output reports. Additional anecdotal evidence from third party evaluators also suggests that not all changes in the user input screens ripple through the complete model. The most fre-

quently cited example of this is that a substantial increase in the amount of assumed plant does not result in a proportional increase in total cost. While we cannot confirm these at the present time, we do express our concern about these matters and encourage more detailed review of the Hatfield Model Version 3.0/3.1 to confirm their veracity.

While we recognize that the Hatfield Model is still under development in Release 3.0, we also suggest that the user interface should be more stable before the Hatfield Model is disseminated for use in the industry. We also believe that the Hatfield Model Version 3.0/3.1 should be modified to support use of current versions of the basic platform software (the Microsoft Office 97 versions of Excel and Access).

Conclusion

Version 3.0/3.1 of the Hatfield Model provides advances and enhancements in several areas relative to Version 2.2, Release 2. Nevertheless, as described in this report, there are several outstanding problems and significant shortcomings in the Hatfield Model Version 3.0/3.1. Cumulatively, these shortcomings constitute strong evidence of an unacceptable bias in design that would preclude use of the Hatfield Model Version 3.0/3.1 in any real world design or cost analysis. These shortcomings also indicate a weak design embedded within the software, a weakness that probably could not be overcome by simply recompiling the code or transferring the underlying design to another software application package.

Appendix A. Hatfield Model 3.1-Specific Changes

Introduction

The sponsors of the Hatfield Model released Version 3.0 on February 7, 1997 and Version 3.1 on February 28, 1997. We have found that few substantive changes were made to the software between the two versions, as should be expected because of the brief interval between releases. For example, Version 3.1 still does not function under current versions of Microsoft software (Office 97). We combined our evaluation of these models to simplify analysis and interpretation and summarize here the changes relevant to the level of analysis presented.

Data

The principal change in Version 3.1 appears to be the provision of data for 49 states and District of Columbia. There is some question as to the exact number of additional states for which data are provided in Version 3.1 vis-à-vis Version 3.0/3.1. This question surrounds the interpretation of the pre-release data for Ohio in Version 3.0/3.1 and the quality of the California data in Version 3.0/3.1 (which precluded analysis). We have not tested all data sets for all states and express no opinion on data quality. Data for Puerto Rico are still unavailable and no data was provided for Alaska.

It appears that the terrain data used in the model are the same terrain data as those incorporated in previous versions of the Hatfield Model, as derived from the original BCM. A question concerning the license status of these data has been raised in public discussion. No changes or additions to this data set are reported.

Function

Version 3.1 permits summary reports by CBG in addition to the summary reports by wire center and density group supported in Version 3.0.

The algorithm used to determine switch costs has been modified. The Version 3.1 generates cost results that are lower than those produced by Version 3.0 (and more closely approximating those provided in Version 2.2.2).

Anecdotally, results for United Telephone of Washington cannot be generated using Version 3.1 of the model, although results were produced using Version 3.0. We have not yet confirmed the extent of this phenomenon.

Conclusion

Other features appear to remain essentially unchanged in Version 3.1 of the software. Numerous minor changes appear to have been made but the final costs generated differ little from those generated by Version 3.0 for selected test areas in the Southwestern Bell Texas service area.